Page 1, lines 2-11, replace entire paragraph with the following: --This invention relates to medical instruments, systems and methods and, more particularly, to medical instruments, systems and methods for use in imaging a site in a medical procedure.--

A2

Page 3, line 8, replace "and displayed on a video monitor or" with --to generate a video output signal used to produce an output image displayed by a video monitor, printed by a printing device, and/or--.

A3

Page 5, line 8, replace "operating" with --operative--.

Page 5, line 12, replace "compensator" with --processor--.

Page 5, line 18, before "For example", insert the following: -- Differential picture brightness tends to take different forms.--

Page 5, line 25, after the sentence, insert the following: "As yet another example, differential picture brightness may arise due to deficient alignment of the illumination with the site/area being imaged. In this latter form, differential picture brightness is typically characterized by a bright portion toward one side of the picture, decreasing brightness with disposition toward the picture's other side and a dark or black crescent or other portion of the picture adjacent that other side's periphery. In any form, differential picture brightness is characterized by spatial differences (particularly, observable differences) in brightness, e.g., from one picture edge, through the picture center, to an opposite picture edge or otherwise across or among spatial components of the picture.--

A4

Page 6, line 5, after "brightness", insert --(e.g., by reducing spatial differences)--.

Page 7, line 20, replace "discloses" with --purports to disclose--.

Page 8, line 9, replace "discloses" with --purports to disclose--.

Page 8, lines 12-15, delete the sentence "The correction system is capable ...to a digitized video signal."

Page 8, lines16-20, replace "for identifying the required correction within a video frame, a calculating portion for computing the amount of correction to be applied to the video signal, and a correction portion for correcting the video signal based upon the correction computed by the calculating portion" with --for inspecting the amplitude of the output of the pixels which are part of the video image when the image is that of a flat white calibration target, a calculator portion for calculating for each pixel inspected a white shading correction coefficient, and a correction portion for correcting pixels in subsequent video images based on the white shading correction coefficients calculated by the calculator portion--.

Page 8, line 21, replace "discloses" with --purports to disclose--.

Page 9, line 3, replace "date" with --data--.

Page 9, line 7, replace "Patents 4,979,598 and 4,979,042" with --Patent 4,979,042 purports --.

Page 10, lines 1-4, replace "The above described prior art represent the typical electronic correction devices and methods to correct shading in an optical image for a variety of video imaging apparatus and system." with --The above-identified references indicate approaches directed to correction of shading associated with inherent deficiencies in either/both the imaging performance of video cameras/sensors and such cameras' optics. As previously described, other known approaches are directed to optimizing light sources and guides. Notwithstanding these approaches, alone or together, differential picture brightness remains a problem in acquired images of interior spaces due to illumination deficiencies.--

Page 10, after line 4 and before line 5, insert the following paragraphs:

--Differential picture brightness due to illumination deficiencies remains a particularly significant problem in the medical field wherein a patient's health typically is at stake. As an

example, the success or failure of laparoscopic surgery may depend in substantial part on the quality at which the operative site is imaged for the surgery team.

A7 Accordingly, there is a need for medical imaging instruments, apparatus and methods that address illumination deficiencies, particularly uneven illumination of the operative site/inspection area.--

Page 10, line 18, change "compensating signal used " to --compensated video signal, or for using the compensating signal to --.

Page 10, line 12, change "compensating video signal used" to --compensated video signal, or for using the compensating signal to --.

Page 10, line 13, delete "video".

Page 14, line 21, change "located as or" to --or a light source--.

Page 15, line 5, replace "optical" with --medical--.

Page 15, line 6, replace "imager" with --image--.

Page 19, line 21, replace "the" with --a--.

Page 20, line 1, replace "processing" with --processor, and an--, and replace "with the" by --, including a--.

Page 20, line 6, replace "a monitor" with --an output device, and --.

Page 20, line 11, replace "a monitor" with --an output device, and --.

Page 20, line 12, replace "processor" with --compensator--.

Page 20, lines 14-23, replace "Fig. 12(a) and 12(b) represent...respectively;" with

A8 --Figs. 12(a) and 12(b) show, respectively: (i) a video signal representing an optical image having differential picture brightness and (ii) a compensated video signal representing an optical image having substantially uniform brightness.--

Page 20, line 24, replace "Fig. 13(a) and 13(b)" with --"Figs. 13(a) and 13(b)-- and, after "of", insert --respectively--.

Page 21, line 2, replace "of" with --(ii)--.

Page 21, line 3, delete ";" and "(ii)".

Page 21, line 4, delete ", respectively".

Page 21, line 8, replace "are waveforms" with --show, respectively, a waveform--.

Page 21, line 12, delete ", respectively".

Page 21, line 18, change "the differential" to --differential--.

Page 21, lines 19-23, delete "cross-sectional...from the digital signal processor".

Page 21, line 25, replace all with --a--.

Page 22, lines 2-3, replace "having the ...processor having" with --and--.

Page 22, line 9, replace "the" with --a--.

Page 22, line 14, replace "which" with --of Fig. 19 which sensing device--.

Page 22, line 15, after the paragraph, insert the following paragraph: --Fig. 22 is a high level block diagram of a medical imaging instrument or system, in accordance with the invention.--

A9

Page 22, line 16, replace "DESCRIPTION OF THE PREFERRED EMBODIMENT" with --DETAILED DESCRIPTION--.

Page 22, line 23, after "camera.", insert the following sentence: --As an example, the following review will provide background to advance understanding of the application and utility of the present invention in medical imaging instruments, apparatus and methods. The background is directed particularly to video applications, wherein the invention is directed to enhance real-time motion signals (e.g., frame by frame). --

A10

Page 23, line 7, replace "CCD" with --video sensor (e.g., a CCD)--.

Page 23, line 11, after "as", insert --an--.

Page 23, line 14, replace "Format" with --format--.

Page 23, line 19, replace "a" with --an--.

Page 23, line 24, replace "Format" with --format--.

Page 23, line 24, through page 24, line 6, create a new paragraph beginning with "It is also envisioned...".

Page 24, line 4, after "of", insert --either--.

Page 24, line 5, replace "The Format" with --format, or the term "format" alone in appropriate context--.

Page 24, line 7, after "sensor", insert a comma.

Page 24, line 14, replace "Format" with --format--.

Page 24, lines 15-17, replace "The video signal compensator...video camera." with --Each of the above-described video cameras, as well as other video cameras, are expressly contemplated within the scope of the invention. Moreover, the video sensors of such cameras may be variously implemented without departing from the principles of the invention.--

A11

Page 24, line 18, replace "a video sensor" with --any video sensor--.

Page 24, lines 19-21, replace "line sensor...invention including" with --including solid state sensors and tube-based sensors, including, as non-exhaustive examples, line sensors, area sensors, CCDs, CMOS sensors and other photodiode/photoconductor arrays, as well as vidicon and orthicon tubes and combinations of same. The term "video sensor" includes--

A12

Page 24, line 24, replace "at a CCD" with --(a)--.

Page 24, line 25, after "located", insert --at-- and replace "or to a video", with --or (b) a sensor of a video--.

Page 25, line 1, after "camera", insert --, the camera being-- and replace "an optical instrument, endoscope" with --a medical instrument (e.g., an endoscope)--.

Page 25, line 3, replace "optical instrument" with --medical instrument--.

Page 25, lines 4-5, replace "a CCD sensor or video camera" with --the video sensor--.

Page 25, lines 10-11, replace "a rigid, elongated sheath tube 32" with --a housing 32 (e.g., a rigid sheath tube)--

Page 25, line 14, replace "means," with --structure. The optical image transferring structure may be variously implemented, including as a--.

Page 25, line 15, replace "typically" with --but typically comprises-- and replace "lenses," with --lenses. In any case, the optical image transferring structure provides--.

Page 25, line 16, replace "through" with --(through--.

Page 25, line 17, replace "ridged elongated sheath tube 32" with --housing 32)--.

Page 25, line 18, at the end of the paragraph, insert the following: --Although the elongate housing 32 is generally referred to herein as being rigid, it is understood that the housing and, in turn, the instrument 30 may be other than rigid (e.g., flexible or semi-flexible), without departing from the principles of the invention.--

Page 25, line 21, replace "means for supporting" with --structure to support--.

Page 25, line 22, replace "means for defining" with --structure to define--.

Page 25, line 24, replace "Valve means" with --Valves--.

Page 26, lines 7-8, replace "processing means, for example 134 in Fig. (8), " with --processor (such as processor 134 of Fig. 8)--.

Page 26, line 10, replace "means" with --device, or for printing the image, or for other purposes--.

Page 26, line 22, delete "shown as".

Page 26, line 25, replace "rigid elongated sheath tube 32" with --housing 32--.

Page 27, line 3, at the end of the paragraph, insert the following:

A16 --(Hereinafter, the operative site and inspection area are sometimes referred to, alone or together, as the "target site".)--

Page 27, line 12, as the end of the paragraph, insert: --The light energy typically is

A17 white, visible light; however, it is to be recognized that the light energy may include frequency components outside the visible light spectrum, either supplemental to or in substitution for some or all of the white light frequencies. Examples include infrared and x-ray radiation. --

Page 28, line 2, replace "and" with --and/or--.

Page 28, line 8, replace the comma with a period.

Page 28, line 10, delete "is".

Page 28, line 11-12, replace "and illuminates" with --to illuminate--.

Page 28, line 17, replace "means" with --structure--.

Page 28, line 18, replace "rigid elongated sheath tube 32" with --housing 32--.

Page 28, line 19, replace "means" with --mechanism--.

Page 28, line 20, replace "means" with --device--.

Page 28, lines 20-21, delete "shown generally as".

Page 28, line 21, replace "means" with --device--.

Page 28, line 22, replace "of member" with --or member--.

Page 28, line 23, replace "means" with --device--.

Page 28, line 24, replace "may be" with --comprises one or more of --.

Page 28, line 24, replace "for a CCD" with --for or of a CCD--.

Page 28, line 25, replace ", or video sensor" with --(or other video sensor), fiber optics, --.

Page 28, line 25, replace "means" with --mechanism--.

Page 29, lines 1-2, replace "is shown generally as" with --comprises a--.

Page 29, line 3-4, delete "shown as" and "which houses...through 7".

Page 29, line 4, insert at the paragraph's end, the sentences: --In Figure 3, the mechanism that directs fluid flow across the exterior surface of the image passing device also comprises a second nozzle 82, such nozzle being located in the space 70 at a selected distance from nozzle 80. Such mechanism may comprise any selected number of nozzles 80, 82 and/or other selected structure.--

A18

Page 29, line 4, after "nozzle", insert --80-- and, after "channel", insert --86--.

Page 29, line 7, replace "transparent member" with --image passing device--.

Page 29, line 9, delete the comma.

Page 29, line 10, replace "transparent member" with --image passing device-- and replace "second" with --irrigation--.

Page 29, line 13, replace "transparent member" with --image passing device--.

Page 29, line 16, at the paragraph's outset, insert the following sentence: --The fiber optic light guide 72 typically comprises one or more light fibers, bundled or otherwise.--

A19

Page 29, line 16, after "are", insert --arranged in plural bundles, the bundles being disposed in space 70. Typically, as shown, the bundles of light fibers are--.

A20

Page 29, line 21, replace "the illustrated" with --that illustrated--.

Page 29, line 22, replace "uses" with --purposes--.

Page 29, line 25, replace "the illustrated" with --that illustrated--.

Page 30, line 2, replace "space" with --spaced--.

Page 30, line 3, delete "optical image transferring".

Page 30, line 10, replace "transparent member" with --image passing device--, and replace "of" with --off--.

Page 30, line 13, replace "transparent member" with --image passing device--.

Page 30, line 14, replace "axis" with --axes--.

Page 30, lines 15-16, replace "rigid elongated sheath tube 32" with --housing 32--.

Page 30, line 25, replace "non-uniform" with --non-uniformity of--.

Page 31, line 2, replace "the compensating" with --as is described further hereinafter, a --.

Page 31, line 3, delete "apparatus or".

Page 31, line 5, after "7", insert --so as--.

Page 31, lines 6-7, replace "due to" with --, notwithstanding the light guide's directing of non-uniform or --.

Page 31, line 10, replace "the light bulb or" with --a light bulb or other--.

Page 31, line 11, replace "The light bulb or" with --As an example, the light bulb or other--.

Page 31, line 12, as the end of the paragraph, insert the following: --(The light bulb, light source, light guide and other structure associated with illuminating a target site are sometimes referred to herein, individually, collectively and grouped, as an "illuminator".)--

Page 31, lines 13-14, replace "compensating apparatus" with --an analog video camera--.

Page 31, line 16, replace "use" with --used--.

Page 31, lines 17-19, delete "developed from...source".

Page 31, line 21, replace "directly" with --directly or indirectly--.

Page 32, line 2, replace "124" with --126--.

Page 32, lines 6-7, replace "or compensating apparatus 130" with --130 (the video signal compensator is sometimes referred to herein as a "compensating apparatus")--.

Page 32, line 8, delete "or compensating apparatus".

Page 32, line 12, change "compensating" to --output--.

Page 32, line 13, delete "or compensating apparatus" and replace "shown as" with --as provided on--.

Page 32, line 16, replace "video" with --signal--.

Page 32, line 17, replace "Format" with --format--.

Page 32, lines 18-19, replace "When ...134, the" with --The--.

Page 32, lines 18-19, replace "When the compensating signal...134, the" with --The--.

Page 32, line 20, between "a" and "video", insert --formatted--.

Page 32, line 22, delete "output".

Page 32, lines 23-24, replace "a monitor, video storage device, printer or other video" with --an output-- and, "after box 138", insert --(Hereinafter, the term "output device" contemplates, without limitation, display devices (e.g., flat panel display technology, light valve technology, tube technology or otherwise), printing devices, storage devices (e.g., CD, DVD or other optical or magneto-optical storage, VCR, RAID, hard drive, or other analog/digital, temporary/semi-permanent/permanent storage), networking devices and other similar devices.)--

Page 33, line 5, replace "CCD" with --video--.

Page 33, line 8, after "signal", insert --so as--.

Page 33, line 9, replace "processor" with --processing apparatus 128--.

Page 33, line 10, replace "preamplifier" with --amplified--.

Page 33, line 11, before "compensating", insert --the-- and, after "added", insert --, multiplied, mixed, interpolated, extrapolated or otherwise applied together before or at--.

Page 33, line 12, replace "process a" with --outputs a formatted,--.

Page 33, line 13, at the end of the paragraph, insert the following as a new paragraph:

--As is readily apparent to anyone of skill in the art, the compensating signal may be variously applied to the video signal. As an example, the compensating signal may be applied within the video signal processor 134. To do so, the video signal processor 134 has applied, as inputs, the compensating signal and the amplified video signal, each via output 132. The so-input amplified video signal, in such case, is passed through the video signal compensator 130. In such case, the video signal processor 134 may apply the compensating signal so as to control the processing (e.g., the gain) of the video signal, or it may add, multiply, mix, interpolate, extrapolate or otherwise process the compensating signal with the video signal. As another example, the video signal compensator 130 generates the compensating signal and applies that compensating signal with the video signal, so as to output to the video signal processor 134 a compensated video signal for formatting. The application is implemented by adding, multiplying, mixing, interpolating, extrapolating or otherwise applying together the compensating signal and the video signal.

The compensator 130 may be variously implemented in generating the compensating signal. As an example, the compensator 130 can be implemented to generate the compensating signal from components of the video signal. These components typically include one or more, or combinations of: timing components, synchronization components, and test, marker or other references embedded in the video signal (e.g., in the content portion thereof). Use of embedded references engenders advantages, including enabling the system to recognize and track changes in the orientation of the endoscope. Such changes, which typically arise from manipulations related to the applicable medical procedures and which include rotation about the endoscope's elongate axis, tend to result in variations in illumination, including changes in

differential picture brightness. If the differential picture brightness characteristics are the same, but merely rotated or otherwise re-oriented, the tracking enable the compensation to be adapted thereto.--

Page 33, line 14, after "add", insert --multiply, mix, interpolate, extrapolate, or otherwise apply together the amplified video signal and--.

Page 33, line 15, delete "to the video signal" and, before the period, insert --to a pre-selected format--.

Page 33, line 18, replace "directly" with --directly or indirectly--.

Page 33, line 22, replace "output" with --conductors--.

Page 34, line 3, replace "analog" with "digital".

Page 34, line 8, replace "Format" with --format--.

Page 34, line 10, delete "then".

Page 34, lines 11-12, replace "added to and compensates...to represent" with --added, multiplied, mixed, interpolated, extrapolated or otherwise applied with the video signal output by the digital-to-analog converter 150, so as to produce a formatted, compensated video signal representing--.

Page 34, line 13, replace "illumination." with --brightness. As an example, the video signal compensator 154 generates the compensating signal and applies that compensating signal with the video signal. The application is implemented by adding, multiplying, mixing, interpolating, extrapolating or otherwise processing together the compensating signal and the video signal.--

Page 34, line 13, replace "output" with --video--.

Page 34, line 15, replace "video" with --output--.

Page 34, line 16, replace "waveform" with --signal--.

Page 34, line 16-17, replace "added ...processor." with --otherwise introduced.--

Page 34, line 19, replace "added to the video signal" with --produced--.

Page 34, line 23, replace "directly" with --directly or indirectly--.

Page 35, line 4, replace "an analog-to-digital converter" with --video signal compensator--.

Page 35, line 5, replace "a compensated analog" with --an analog compensated--.

Page 35, lines 6-7, replace "differential ... illumination." with --substantially uniform brightness.--

Page 35, lines 8-9, replace "wherein the digital signal is" with --wherein the output is a digital signal that is--.

Page 35, line 10, after "digitized", insert --, formatted--.

Page 35, line 12, replace "163 wherein the output signal from" with --163. The output of--.

Page 35, line 13, replace "processed" with --formatted--.

Page 35, lines 14-15, replace "differential ... illumination" with --substantially uniform brightness--.

Page 35, line 17, replace "video" with --output--.

Page 35, line 19, before the paragraph, insert the following paragraph: --As described, the digital signal processor 162 has applied, as an input, the compensated video signal output from the video signal compensator 160. To do so, the compensator 160 adds, multiplies, mixes, interpolates, extrapolates or otherwise applies the compensating signal with the amplified video signal. In the alternative, the compensator 160 generates the compensating signal and passes through the amplified video signal, both as inputs to the analog-to-digital converter 161. In the latter case, either the analog-to-digital converter 161 or the digital signal processor 162 applies the respective signals to produce the compensated video signal. --

Page 35, line 23, replace "directly" with --directly or indirectly--.

Page 36, lines 4-6, replace "where the output...uneven illumination" with --so as to output a formatted, compensated video signal representing the optical image having substantially uniform brightness--.

Page 36, line 8, replace "Format" with --format--.

Page 36, lines 10-11, change "in the preselected format" to --(e.g., in or responsive to the preselected format)--.

Page 36, lines 11-13, replace "added to and compensates...uniform illumination" with --added, multiplied, mixed, interpolated, extrapolated or otherwise applied with the formatted video signal, so as to produce the formatted, compensated video signal--.

Page 36, line 15, replace "video" with --output--.

Page 36, line 16, create a new paragraph starting with "It is envisioned...".

Page 36, line 17, replace "used" with --implemented--.

Page 36, line 18, replace "even in ...processor" with --integral with the video signal processor (whether analog or digital)--.

Page 36, line 19, replace "the" with --a--.

Page 36, line 20, replace "162" with --171-- and replace "the" with --a--.

Page 36, line 21, replace "The" with --A--.

Page 36, line 22, replace "for brightness is shown as 170" with --170 is depicted which represents an optical image having substantially uniform brightness--.

Page 36, line 23, replace "162" with --171--.

Page 36, line 24, replace "a reference 170" with --the optical image represented by the reference line 170,--.

Page 37, line 1, after "image", insert --118--.

Page 37, line 2, after "than", insert --the optical image represented by-- and, after "reference", insert --line--.

Page 37, lines 4-18, replace "the optical image...substantially uniform brightness." with the following: --the optical image of Fig. 12(a) having substantially uniform brightness. The compensated video signal of waveform 178 is generated by conditioning the waveform 171. In this illustration, the waveform 178 is generated by conditioning the waveform 171 with one or more compensating signals so that (a) the amplitudes of the portion 174 of waveform 171 which are brighter than desired are appropriately decreased to form portion 180 of waveform 178, (b) the amplitudes of the portions 172 of waveform 171 which are less bright than desired are appropriately increased to form portions 180 of waveform 178 and (c) the amplitudes of the portions 172 of waveform 171 which correspond to sites which are expected to be non-illuminated or non-imaged are appropriately decreased to form portions 181 of waveform 178. As such, the waveform 178 corresponds substantially closely at relevant times to the level of the reference line 170, such correspondence reflecting an optical image having substantially uniform illumination.

It is to be recognized that, while Figs. 12(a) and (b) respectively depict a small portion of a video signal and its compensated video signal (e.g., one line of video content for a video frame), the deficiencies and compensation therefor as illustrated therein are applicable to these signals for the optical image entirely or in any selected part, whether described vertically, horizontally and/or radially, or otherwise. That is, the compensation or other conditioning preferably is directed to ameliorate or correct differential picture brightness spatially.--

Page 37, line 19, replace "represent" with --represents-- and replace "wherein" with --having--.

Page 37, line 20, delete "the", insert a period after "brightness" and replace "of an" with --The--.

Page 37, line 22, replace "portion" with --portions--.

Page 37, line 23, replace "line" with --lines--.

Page 37, lines 23-25, replace "depict the...less bright" with --depict acceleration in the decrease of brightness toward the optical image's periphery 190--.

Page 37, line 25, at the end of the paragraph, insert the following sentence: --The shaded portion about the optical image's center 188 indicate brightness (uniform or otherwise) that exceeds a desirable level.--

Page 38, line 1, replace "represent" with --represents-- and replace "wherein" with --having--.

Page 38, line 2, delete "the", insert a period after "brightness" and replace "of an" with --The--.

Page 38, line 4, replace "portion" with --portions--.

Page 38, line 5, replace "line" with --lines--.

Page 38, lines 5-7, replace "depict the...at the center 198" with --depict acceleration in the decrease of brightness toward the optical image's center 198--.

Page 38, line 7, at the end of the paragraph, insert the following new paragraph: --It is to be understood that, although Figs. 13(a) and 13(b) depict radially symmetric brightness functions (e.g., brightness levels vary but the variations are consistent among radii, with such variations being functions of disposition along a radius and not the radius' angle), such symmetry may be absent in practice. That is, brightness may be anywhere from less symmetric to partly or wholly asymmetric, including by varying either/both by radial disposition and angle. In addition, brightness may be characterized by variations in either/both horizontal and vertical dimensions associated with the optical image.--

Page 38, line 18, before "which", insert --(--, and replace "of the" with --an--.

Page 38, line 19, after "8", insert --)--.

Page 38, line 20, replace "the form of the basic" with --compensating waveforms" and replace "are used in" with --associated with--.

Page 38, line 21, after "compensator", insert a period and replace the remainder of the line with --Although only sawtooth and parabolic waveforms are discussed in the following descriptions, it is recognized that either or both of these waveforms may be omitted, and that any number and variety of other waveforms may be employed (alone or in combinations with the sawtooth and/or parabolic waveforms), without departing from the principles of the invention. As an example, such other and combinations of waveforms may be employed when the differential picture brightness is characterized by partly or wholly asymmetry. As another example, the waveforms may be preset, so as, e.g., to correlate to and correct known deficiencies associated with medical imaging instruments and systems. As to this latter example, the preset waveforms preferably are brought into operation either manually or automatically, (e.g., by detection of the imaging instrument or one or more components of a system--

Page 38, line 22, delete all.

Page 38, line 25, replace "the" with --addressing--.

Page 39, line 1, replace "to produce" with --toward producing--.

Page 39, line 2, delete "a".

Page 39, line 9, at the end of the paragraph, insert: --The sawtooth wave generators described, as well as selected additional sawtooth wave generators, may be integral, grouped or separate, without departing from the principles of the invention.--

Page 39, line 16, at the end of the paragraph, insert: --Plural parabolic wave generators may be provided, whether integral, grouped or separate, without departing from the principles of the invention.--

Page 39, line 21, replace "the sawtooth" with --each sawtooth--.

Page 39, line 22, replace "the parabolic" with --each parabolic--.

Page 39, line 23, delete "as required".

Page 39, line 24, after "In operation,", insert --a typical implementation of a video signal compensator provides--.

Page 40, line 19, delete "as required".

Page 40, line 21, replace "136" with --236--.

Page 40, line 22, replace "136" with --236--.

Page 41, line 5, delete the comma.

Page 41, line 6, replace "a" with --the--.

Page 41, line 10, delete the comma.

Page 41, lines 12-13, delete "having a controlled amplitude and orientation".

Page 41, line 15, replace "136" with --236,--.

Page 41, line 21, replace "waveform generator" with --wave generator--.

Page 42, line 3, replace "is" with --are--.

Page 42, line 6, replace "Amplifier" with --amplifier--.

Page 42, line 7, replace "issued" with --is used--.

Page 42, line 12, replace "302" with --286--.

Page 42, lines 13-14, replace "depicted as balance network 286 and the" with --, which--.

Page 42, line 16, delete "input".

Page 42, line 20, after "having", insert --a predetermined falling slope and controlled amplitude in the form of sawtooth waveform 212--.

Page 42, line 23, replace "a" with --the--.

Page 43, line 1, delete the comma.

Page 43, line 4, delete both quotation marks.

Page 43, line 5, replace "302 of ", with --302, which is-- and, after "286", insert a comma.

Page 43, line 7, replace "waveform" with --waveforms--.

Page 43, line 11, replace "waveform generator" with --wave generator--.

Page 43, line 19, replace "to represent the" with --toward such video signal representing an--.

Page 43, line 23, replace "the desire" with --a selected--.

Page 44, line 7, replace "An adder" with --Typically, an adder or other component--.

Page 44, line 8, replace "add" with --add, multiply, mix, interpolate, extrapolate or otherwise apply together--

Page 44, lines 13-15, replace "required for the differential ...compensating signal" with --facilitating production of a compensated video signal (i.e., a video signal representing an optical image having substantially uniform brightness) from a video signal representing an optical image having differential picture brightness.--

Page 44, lines 15-16, delete "the parabolic waveform would be used alone".

Page 44, lines 19-20, replace "at least...brightness. In the" with --an optical image having decreased differential picture brightness (i.e., increased uniformity in brightness). In a--.

Page 44, line 22, before "produce", insert --to-- and, after "signal", delete "used".

Page 44, lines 23-24, delete all.

Page 45, line 1, replace "is added to" with --typically is added, multiplied, mixed, interpolated, extrapolated or otherwise applied with--.

Page 45, line 2, delete "at the input of a video signal processor 134".

Page 45, line 3, replace "compensating" with --compensated-- and replace "process" with --processing apparatus 128 preferably--.

Page 45, line 4, replace "the gain" with --gain--.

Page 45, line 5, after "horizontally", insert --, e.g., -- and replace "gain of" with --gain applicable to--.

Page 45, line 7, replace "reference and" with --reference level and/or, e.g., by--.

Page 45, line 9, replace "a reference" with --the same or another reference level and, thereby,-- and, after "an", insert --optical--.

Page 45, line 10, at the end of the paragraph, add the following new paragraph: --It is understood that the compensated video signal may be subject to processing in addition to formatting. As an example, the compensated video signal may be processed to remove artifacts. It also may be processed so as to respond to signal saturation, as might occur when, during a medical procedure, a reflective medical instrument enters a portion of the target site characterized by an enhanced gain via a compensating signal. In that event, the enhanced gain typically would be reduced and, preferably, that reduction would be implemented on a dynamic basis.--

Page 45, lines 11-12, replace "In the ...brightness" with --In a typical case, an optical image--.

Page 45, line 13, replace "adder adds the sawtooth waveform," with --, implemented according to Figure 16, adds, multiplies, mixes, interpolates, extrapolates or otherwise applies together one or more sawtooth waveforms and--.

Page 45, line 14, replace "and the video signal" with --(and, in some embodiments, the video signal or portion(s) thereof), such waveforms being properly balanced and otherwise calibrated,--.

Page 45, line 15, after the first "signal" and after "processor", insert respective periods, and replace "which" with --The compensating signal typically is employed within the video signal compensator or--.

Page 45, line 16, replace "adjusting its gain" with --So employed or applied, the compensating signal preferably adjusts the gain applicable to the video signal, e.g.,--.

Page 45, line 17, after "accomplished", insert --, typically,-- and replace "of" with --applied to--.

Page 45, line 18, after "response", insert --to--.

Page 45, line 19, replace "of" with --applied to--.

Page 45, line 21, after "image", insert a comma.

Page 45, line 23, replace "In the event that the differential picture brightness of" with --In another typical case, wherein--.

Page 45, line 24, replace the period with a comma.

Page 45, line 25, replace "The adder adds the sawtooth waveform," with --the video signal compensator typically adds, multiplies, mixes, interpolates, extrapolates or otherwise applies together one or more sawtooth waveforms and-- and delete "and".

Page 46, line 1, replace "the video signal" with --(and, in some embodiments, the video signal or portion(s) thereof), such waveforms being properly balanced and otherwise calibrated,--; after "compensating signal", insert a period; and replace "which" with --The compensating signal typically is employed within the video signal compensator or--.

Page 46, lines 2-3, replace "with a ...producing" with --the video signal so as to produce--.

Page 46, line 4, replace "compensated video signal is used to adjust" with --compensating signal, so employed or applied, preferably adjusts--.

Page 46, line 5, replace "signal processor" with --signal, e.g.,--.

Page 46, line 6, replace "of" with --applied to--.

Page 46, line 8, replace "of" with --applied to--.

Page 46, line 10, after "image", insert a comma.

Page 46, line 20, replace "operative" with --target--.

Page 46, line 25, replace "included as part of element 76," with --which includes, in one embodiment, image passing device 76 and--.

Page 47, line 8, after "and", insert --typically--.

Page 47, line 9, replace the comma with --and/or--.

Page 47, line 10, after "slope", insert a comma.

Page 47, line 11, replace "parabola" with --parabolic--.

Page 47, line 12, replace "parabola" with --parabolic--.

Page 47, line 13, replace "An" with --Typically, an--.

Page 47, line 14, replace the comma with --and-- and delete "and a".

Page 47, line 15, delete "video signal".

Page 47, line 17, replace "input to a ... adjusting its gain" with --to adjust the gain applied to the video signal, e.g.,--.

Page 47, line 22, after "reference", insert --, thereby--.

Page 48, lines 1-6, delete all.

Page 48, line 9, replace "directly" with --directly or indirectly-- and change "CCD sensor 400" to --video sensor 400 (e.g., in the form of a CCD)--.

Page 48, line 14, replace "lines" with --box--.

Page 48, line 16, replace "or freeze frame 414 for storing" with --414 (e.g., in the form of a freeze frame).--

Page 48, line 18, replace "received" with --as received--.

Page 48, line 22, after "digital", insert --signal--.

Page 48, line 24, through page 49, line 2, replace "required for the differential ...uniform brightness" with --facilitating production of a compensated video signal (i.e., a video signal representing an optical image having substantially uniform brightness) from a video signal representing an optical image having differential picture brightness.--

Page 49, line 2, after "digital", insert --signal--.

Page 49, lines 6-7, replace "above for...digitally" with --above--.

Page 49, line 7, replace "form" with --from--.

Page 49, line 9, replace "Illuminates" with --Illumination--.

Page 49, line10, delete "to".

Page 49, line 14, replace "output" with --optical--.

Page 49, line 15, replace "390 delay" with --398 delayed--.

Page 49, line 20, replace "first inputs of the adders" with --first adder--.

Page 50, line 1, replace "The output video signal represents" with --These output signals represent--.

Page 50, line 2, replace "a device" with --an output device, such as that--.

Page 50, line 4, insert as new paragraphs, the following:

--In an alternative embodiment, the structures of Figure 17 may be otherwise operated to produce a compensated video signal. Such embodiment contemplates a learning mode and an operating mode. In the learning mode, the freeze frame 414 receives a video signal for characterizing the differential picture brightness. The freeze frame 414 processes the learning-mode video signal so as to identify digital compensation coefficients for each pixel of the frame. As an example, the coefficients may be calculated, as follows: a) determine a reference

brightness for the learning mode frame(s) (e.g., an average brightness value across all or part of the frame, a median brightness value across all or part of the frame or otherwise) and b) dividing, for each pixel, the reference brightness by the pixel's actual brightness for the learning mode frame(s).

In a preferred embodiment, the learning mode provides for detection of flawed or otherwise unacceptable results from the learning mode. In the event of such detection, the learning mode preferably supports one or more default compensations. Such default compensations may be variously implemented. Example implementations include: a) generating digital compensation coefficients that comprise a best fit (e.g., based on the learning mode data that appears to be without substantial flaws, at least to a threshold confidence); b) employing a previous set of compensation coefficients (e.g., as to all or as to part or parts of the optical image); c) bypassing compensation (e.g., as to all or as to part or parts of the optical image); and d) a combination of implementations, including of those implementation not listed above (e.g., selecting among previous sets of compensation coefficients to find a best fit and, if the best fit is deemed unacceptable, implementing a bypass).

In the operating mode, the compensation coefficients are processed via the DAC 420 to generate an analog compensating signal. Concurrently, the DSP receives a digital video signal from the ADC 406. The DSP processes the digital video signal and, via a digital-to-analog functionality, produces an analog illumination signal Y_o on lead 424 and an analog color signal C_o on lead 426. The compensating signal is applied (via adding, multiplying, mixing, interpolating, extrapolating or otherwise) with the illumination signal Y_o and with the color signal C_o, respectively at application components 434, 438. The application components 434, 438 produce compensated video signal, this signal comprising compensated illumination signal Y_m (on output lead 440) and compensated color signal C_m (on output lead 442).

Although Fig. 17 shows only one compensating signal, it is understood that more than one compensating signal may be generated. In particular, it is contemplated that separate compensating signals may be generated toward compensating, respectively, the illumination signal Y_o and the color signal C_o. Moreover, although Figure 17 shows compensation as to Y/C formatted video signals, it is understood that compensation may be applied to a video signal or signal of other formats. As examples, the compensation may be applied to composite video signals, color differential signals, RGB video signals, NTSC, PAL, SECAM or any other format, along or in combination(s). --

Page 50, line 7, replace "directly" with --directly or indirectly-- and replace "CCD" with --video--.

Page 50, line 12, replace "lines 410." with --box 410'. The digital signal processing device 410' produces a compensating signal representing at least one parameter of a compensating waveform facilitating production of a compensated video signal (i.e., a video signal representing an optical image having substantially uniform brightness) from the video signal representing an optical image having differential picture brightness.--

Page 50, line 15, replace "410" with --410'--.

Page 50, lines 15-16, change "or freeze frame 414" with --414 (e.g., in the form of a freeze frame)--.

Page 50, line 17, replace "the differential" with --differential--.

Page 50, line 20 through page 51, line 5, delete "a programmable digital processor ... the programmable digital processor 410' includes".

Page 51, lines 12-13, replace "above for...digitally" with --above--.

Page 51, line 16, replace "bases" with --basis--.

Page 51, line 17, replace "the required" with --a--.

Page 52, lines 3-4, replace "differential picture brightness" with --optical image having--.

Page 52, line 10, at the end of the paragraph, add --It is to be understood that, while the color signal may remain uncompensated, the color signal typically is also compensated.--

Page 52, line 11, insert as new paragraphs, the following:

--In an alternative embodiment, the structures of Figure 18 may be otherwise operated to produce a compensated video signal. Such embodiment contemplates a learning mode and an operating mode. In the learning mode, the freeze frame 414 receives a video signal for characterizing the differential picture brightness. The freeze frame 414 processes the learning-mode video signal so as to identify digital compensation coefficients for each pixel of the frame. The coefficients may be calculated as described above for the alternative embodiment based on Figure 17.

In a preferred embodiment, the learning mode provides for detection of flawed or otherwise unacceptable results from the learning mode. In the event of such detection, the learning mode preferably supports one or more default compensations. Such default compensations may be variously implemented. Example implementations include: a) generating digital compensation coefficients that comprise a best fit (e.g., based on the learning mode data that appears to be without substantial flaws, at least to a threshold confidence); b) employing a previous set of compensation coefficients (e.g., as to all or as to part or parts of the optical image); c) bypassing compensation (e.g., as to all or as to part or parts of the optical image); d) detecting pixel's having sensitivity defects (e.g., individual pixels having hyper-, hypo- or no sensitivity), whether of individual or group(s) of pixels, so as to interpolate, extrapolate or otherwise treat such pixels isolated from other compensation (or other conditioning), and e) a combination of implementations, including of those implementation not listed above (e.g., selecting among previous

sets of compensation coefficients to find a best fit and, if the best fit is deemed unacceptable, implementing a bypass).

In the operating mode, the pixel matrix multiplexer/processor 450 receives a digital video signal from the ADC 406. The multiplexer/processor 450 also receives the digital compensation coefficients from the freeze frame 414, which coefficients serve as a compensating signal in the digital domain. The multiplexer/processor 450 digitally adds, multiplies, mixes, interpolates, extrapolates or otherwise applies the coefficients to the video signal. As such, the multiplexer/processor 450 produces a compensated digital video signal which signal is applied to the DSP 416. The DSP formats the video signal so as to output compensated illumination signal Y_m (on output lead 452) and compensated color signal C_m (on output lead 454).

As to implementations supporting learning modes, it is recognized that, various advantages attach. As an example, such implementations tend to enhance correction of asymmetrical differential brightness. As another example, such implementations tend to enhance correction of dynamic variations in differential brightness, such as those that may result from rotation of an endoscope during a procedure. As yet another example, such implementations tend to enhance correction of variations in differential brightness developing over time, e.g., from the deteriorating performance of the endoscope, any components thereof, and/or any components of the system, including one or more illuminators. --

Page 52, line 12, replace "in" with --on--.

Page 52, line 14, after "has", insert --(a)--.

Page 52, line 16, replace "video information signal portion" with --picture information portion--.

Page 52, lines 18-19, replace "video signal portion 464 representing the picture information" with --picture information portion 464--.

Page 52, line 17, after "and", insert --(b)--.

Page 52, lines 19-20, change "This low level noise portion" to --These low level noise portions 462, 466--.

Page 52, line 25, change "The" to --In one embodiment, the--

Page 53, line 1, after "after", insert --picture information portion 474 of-- and replace "portion" with --portions--.

Page 53, line 2, replace "before the information portion of the signal 474 has" with -- and 474, respectively before and after the picture information portion 474, have--.

Page 53, line 3, replace "portion of the video" with --information portion--.

Page 53, line 4, delete "signal" in both occurrences and, before "information", insert --picture--.

Page 53, lines 5-9, delete "Also, in...picture signal."

Page 53, line 10, replace "the preferred" with --a preferred--.

Page 53, line 17, replace "Schmidt" with --Schmitt--.

Page 53, line 18, replace "require" with --requires--.

Page 54, lines 3-6, replace "required for ...uniform brightness" with --to facilitate production of a compensated video signal (i.e., a video signal representing an optical image having substantially uniform brightness) from the video signal representing an optical image having differential picture brightness--.

Page 54, line 6, replace "adding with an adder" with --adding, multiplying, mixing, interpolating, extrapolating or otherwise applying together with an adder, multiplier, mixer, interpolator, extrapolator or other application component--.

Page 54, line 8, change "compensating video signal" to --compensating signal--.

Page 54, lines 9-10, replace "compensating signal which...processor to adjust its gain" with --compensated video signal. The compensating signal preferably is employed to adjust the gain applied to the video signal. As an example, the compensating signal applies--.

Page 54, line 14, after "reference", insert --, thereby--.

Page 54, line 19, delete "step of adding".

Page 54, line 22, after "response", insert --to--.

Page 55, line 1, after "image", insert --, thereby--.

Page 55, line 5, delete "step of adding".

Page 55, line 8, after "response", insert --to--.

Page 55, line 10, change "edge" to --center--.

Page 55, line 11, after "image", insert --, thereby--.

Page 55, lines 13-14, change "the step of adding includes" to --the step of adding, multiplying, mixing, interpolating, extrapolating or otherwise applying may be accomplished using--.

Page 55, line 17, change "step of adding includes" to --step of adding, multiplying, mixing, interpolating, extrapolating or otherwise applying may be accomplished using --.

Page 55, line 21, change "further includes" to --may further include--.

Page 55, line 22, delete ": (a)".

Page 55, lines 22-23, delete "with a control device...the adder".

Page 55, line 23, change "of" to --associated with--.

Page 55, line 25, before "For", insert --Similarly, the brightness associated with the output video signal may be adjusted (pre- or post-compensation) so as to have a brightness at a selected level below that average, or above or below a reference, or based on some selected calculus. To accomplish this, a control device may be employed, e.g. one operatively coupled to the adder, multiplier, mixer, interpolator, extrapolator or other application component.--

Page 56, line 1, change "further includes" to --may further include-- and delete ": (a)".

Page 56, line 5, change "In the" to --In a--.

Page 56, line 8, change "further" to --preferably--.

Page 56, line 9, after "having", insert --at least one of--.

Page 56, lines 11 and 12, change "parabola" to --parabolic--.

Page 56, line 13, replace "adding with an analog signal adder" with --adding, multiplying, mixing, interpolating, extrapolating or otherwise applying together, using an analog adder, multiplier, mixer, interpolator, extrapolator or other application component, one or more of--.

Page 56, line 14, replace "waveform," with --and--, and replace "and the video signal" with --(and, in some embodiments, the video signal or portion(s) thereof)--.

Page 56, line 15, replace "compensating" with --compensated video--.

Page 56, line 16, change "the preferred" to --a preferred--.

Page 56, line 17, delete "used in".

Page 56, line 21, change "differentiated" to --differential--.

Page 56, line 22, change "the uneven" to --uneven--.

Page 57, line 9, change "person" to --persons--.

Page 57, after line 11, add the following paragraphs:

--Turning to Figure 22, depicted is a high level block diagram of a medical imaging instrument or system 2200, in accordance with the invention. The medical instrument or system 200 comprises illuminators 2212, 2212a, an image acquisition component 2214, an output component 2216 and a conditioning component 2218.

In Figure 22, a target site 2210 is illuminated by illuminator 2212. As previously described, the target site 2210 comprises an operative site and/or an inspection area and the illuminator 2212 comprises one or more of light sources, light guides and the like. The target site

2210, for the purposes of the following description, has an associated target image. A target image is a representation of the target site, the representation being an optical, electronic or other signal, that signal being formatted consistent with signals for driving one or more relevant output devices, photonic devices or interface technologies (the latter terms being defined below).

Generally, the concept of a target image expresses a goal selected for achievement. As an example, in the context of a video display, a target image may be selected that correlates to a display image of the target site, the display image being displayed on a monitor, and wherein a) the target site is illuminated without deficiency (e.g., without unevenness) and b) no other component of the imaging instrument and system (including any video sensor, image transferring structure and monitor) contributes deficiencies in the acquisition, transmittal, processing and display of the image.

The target image generally is associated with selected parameters, qualities and/or characteristics. These parameters, qualities and/or characteristics may extend to the entire image or only to parts thereof (e.g., the target image may comprise a key area that, like a spotlight, draws the attention of the conditioning component). As an example, the target image may be characterized in its omission of differential picture brightness associated with uneven illumination of the target site.

It is understood that a target image may be selected that falls short (and, perhaps, falls substantially short) of being a perfect image of the target site. As an example, the target image may be flawed significantly as to other than the selected parameters, qualities and/or characteristics. As another example, the target image may engender a compromise among one or more parameters, qualities and/or characteristics, with or without a compromise as to one or more other parameters, qualities and/or characteristics (e.g., a best fit).

In a specific case, a target image may be selected to correlate to a display image of the target site wherein the target site is illuminated unevenly. In this case, the target image is

selected with attention to parameters, qualities and/or characteristics relevant to target site illumination. Moreover, the target image may or may not be selected with attention to other parameters, qualities and/or characteristics. (Such other parameters, qualities and/or characteristics, if any, otherwise may or may not have --or may be substantially without-- deficiencies.)

So subject to uneven illumination, this case's target image is characterized by differential picture brightness. The differential picture brightness may, however, be trivial in that spatial variations in brightness below a detection threshold are understood to be undetectable to the human eye. The detection threshold is subject to various factors, including factors relating to the output device (e.g., a printer, a display, the presentation area and dot pitch), the video sensor (e.g., its dynamic range), the site illumination (e.g., the intensity and energy distribution), ambient lighting, the quality and aperture of applicable optics (e.g., of an endoscope), the medical procedure, and the quality of the human eye (specifically or generally), many of which factors are quantifiable through empirical analysis or otherwise.

Accordingly, a target image may be selected which has associated therewith undetectable or detectable differential picture brightness. In the undetectable case, the target image effectively is characterized by the absence of associated differential picture brightness, whether the selected target image correlates to a display image having differential picture brightness at, under or well under the detection threshold. In the detectable case, the target image typically is selected in connection with efforts to reduce differential picture brightness in imaging (i.e., although the flaw remains, it or its impact has been ameliorated). In this latter case, the target image preferably is selected so that the differential picture brightness, while detectable, is acceptable under selected criteria. As an example, the target image may be selected notwithstanding detectable differential

picture brightness, provided that flaw is insufficient to impede an applicable medical procedure or otherwise to engender a non-trivial problem in imaging and use.

Moreover, the detectable case explicates the nature of the compensated video signal of previously described camera embodiments. In such embodiments, the cameras produce compensated video signals which video signals represent optical images having substantially uniform brightness, as contrasted with uncompensated video signals representing optical images having differential picture brightness. In such discussions, the term "substantially uniform brightness" generally corresponds to the employ of a target image which itself corresponds to elimination of differential picture brightness, to reduction of differential picture brightness below the detection threshold, or to having a detectable differential picture brightness that, as determined under the circumstances, is acceptable under selected criteria.

While the descriptions above focus on target images that correlate to display images, the correlation may be selected respecting other output devices, photonic devices or interface technologies, with or without a display device. In any case, a target image is a representation of the target site, the representation being an optical, electronic or other signal of appropriate formatting.

The illuminator 2212 may be variously implemented. In a medical instrument such as an endoscope, as previously described, the illuminator 2212 may be disposed internal to the endoscope's housing. At the same time, the illuminator 2212 may be otherwise disposed, including external to the endoscope (in such case, the illuminator 2212 generally may not be considered a component of the instrument). In a medical system, the illuminator 2212 may be implemented so that the illuminator 2212 is integral with the imaging instrument or separate therefrom.

Moreover, plural illuminators 2212 may be employed, as indicated by second illuminator 2212a in Figure 22. In such case, one or more illuminators 2212, 2212a may be integral

with the imaging instrument and/or one or more illuminators 2212, 2212a may be external to such instrument, or some combination of integral and external illuminators may be used.

As previously described, the illuminators 2212, 2212a may direct selected illuminating frequencies onto the target site 2210. While white light is typical, it may be supplemented with, or substituted by, other frequencies outside the visible spectrum. These supplemental/substitute frequencies may be variously implemented, particularly when plural illuminators 2212 are employed. The supplemental/substitute frequencies may be variously employed, including, as examples, toward enhancing acquisition, conditioning and/or output of an image (as described below) or toward recognition of the target site, portion(s) thereof and/or anomalies therein (such recognition may also be employed in the enhancing process).

In any case, the illuminators 2212 generally provide deficient illumination. In particular, illuminators 2212 typically subject the target site 2210 to uneven illumination.

The image acquisition component 2214 generates one or more acquired images of the target site. An acquired image may be an optical, electronic (e.g., video) or other signal, or a combination thereof. An acquired image generally results from illumination of the target site 2210, as provided by the illuminators 2212.

The image acquisition component 2214 may be variously implemented. The image acquisition component 2214 typically comprises one or more video sensors, optical image transferring structures, and other mechanical, optical, electronic, opto-mechanical, electro-mechanical, and electro-optical components.

The image acquisition component 2214 may be variously disposed. The disposition depends, among other things, on its implementation and, in some cases, on the implementation of the output component 2216. The disposition also depends on whether the component 2214 is implemented as part of a medical instrument or as part of a medical system. As an example, if the

image acquisition component 2214 is implemented as a CCD without an optical image transferring structure, the component 2214 typically is disposed at or adjacent the distal tip of an endoscope, so as to generate a video signal that, via electrical connectors, is provided to either/both the conditioning component 2218 and the output component 2216. As another example, however, if the image acquisition component 2214 is implemented to include a CCD which is disposed away from the endoscope's distal tip or remotely from the endoscope itself, the image acquisition component 2214 typically will be implemented also to include an optical image transferring structure, such structure disposed so as to receive the optical image of the target site and provide that image to the CCD so that the CCD may generate one or more acquired images. (Indeed, in such latter case, the image acquisition component 2214 generates at least two acquired images -- one being an optical signal of the structure and another being an electronic signal from the CCD.)

The output component 2216 generates one or more output images, the output images being available on output 2226. An output image may be an optical, electronic (e.g., video) or other signal, or a combination thereof. The output image preferably correlates to, or achieves substantial correlation to, the target image. As an example, if the target image is selected so as to have differential picture brightness that is undetectable over some portion of an image, the output image preferably achieves undetectability over that entire portion or over substantially all of the portion and, where that undetectability is not achieved respecting that portion, the output image preferably achieves substantial undetectability. In any case, correlation may be deemed present provided that the agreement of the output image with the target image is sufficient to preclude any significant impediment to the use of the instrument/system/method (including respecting any applicable medical procedure) and does not engender a non-trivial problem in imaging or related thereto.

The output component 2216 is variously implemented. Typically, the output component 2216 comprises a display device (e.g., as previously described, flat panel display

technology, light valve technology, tube technology or otherwise), a printing device, a storage device, a networking device or some other output device. The output component 2216 may also comprise one or more optical lenses, lens groups, fiber optics (e.g., a fiber optic bundle having one or more optical fibers), or other photonic device. The output component 2216 may also comprise an interface or other connection technologies (all referred to sometimes hereinafter as "interface technology"), including to or with any one or more of such output devices and/or photonic devices. The output component 2216 may also comprise a combination of output devices, of photonic devices, of interface technology, or any groups of same.

As an example, the output component 2216 may be implemented integrally with an endoscope. The output component 2216 may comprise an interface which directs output images (e.g., as formatted or unformatted video signals) to a remote output or photonic device 2228 (e.g., a display device). In such case, the output/photonic device 2228 typically is considered to be part of the medical system, but not part of the endoscope itself. Moreover, as previously described with respect to Figures 1 and 2, the output component 2216 may be operatively coupled to the endoscope, but considered separate therefrom.

The output component 2216 is variously disposed. The disposition depends, among other things, on its implementation and, in some cases, on the implementation of the image acquisition component 2214. The disposition also depends on whether the component 2216 is implemented as part of a medical instrument or as part of a medical system. As an example, if the output component 2216 comprises a monitor or a head mounted display, that component 2216 is likely to be disposed remotely from an endoscope. As another example, the output component 2216 may be integral with the endoscope, particularly if implemented as a small display device (e.g., a miniature LCD-on-silicon display and associated optics, all integrated as the endoscope's eyepiece).

The conditioning component 2218 may also be variously implemented. Generally, the conditioning component 2218 provides for selective conditioning of one or more acquired images, one or more output images or one or more intermediate images (such intermediate images typically being derived from acquired and output images) or combinations of same. To illustrate, if the image acquisition component is implemented to generate acquired images comprising optical and electrical signals, the conditioning component generally is implemented so as to provide for selective conditioning of both. Similarly, if the image output component is implemented to generate output images comprising optical and electrical signals, the conditioning component generally is implemented so as to provide for selective conditioning of both. In either such case, it is preferred that the conditioning component provides appropriate conditioning, e.g., conditioning appropriate to the respective image signal and to the respective image output component.

Although the conditioning component may apply conditioning to various images, the conditioning component generally is directed to enhance correlation of the output image to the target image. In a preferred embodiment, the conditioning component selectively reduces differential picture brightness across all or selected portions of the output image. In another preferred embodiment, the target image has an associated energy profile and the conditioning component conditions so as to enhance correlation of the energy profile of the output image to energy profile of the target image. Generally, the conditioning is performed in connection with and to improve performance in an applicable medical procedure.

The conditioning component provides for conditioning by (i) selectively processing all or selected portions of at least one of the acquired image, the output image and the intermediate image or (ii) selectively controlling at least one the image acquisition component and the image output component. In the first case, the conditioning component generally provides directly for processing of the images, e.g. in the conditioning component itself. As an example, in the above

camera embodiments, the conditioning component is sometimes implemented as or within the video signal compensator, which compensator not only generates a compensating signal, but typically applies that signal to the video signal, so as to generate a compensated video signal.

In the second case, the conditioning component provides indirectly for processing. To illustrate, the conditioning component may generate control signals that direct operation of a digital component or may generate analog signals that control (e.g., via gain circuits, active filters, etc.) the performance of other components' processing the applicable acquired, output or intermediate signal. As an example, where the image acquisition component has an acquisition area and has brightness sensitivity that is controllable as a function of acquisition area position, the conditioning component may be implemented to condition the acquired image by selectively controlling the brightness sensitivity of the image acquisition component. In another example, where the image output component has a output space and has brightness sensitivity that is controllable as a function of position in the output space, the conditioning component may be implemented to condition the output image by selectively controlling the brightness sensitivity of the image output component. The output space tends to be particular to the applicable output device, photonic device or interface technology (e.g., an output image that drives a monitor may have an output space correlating to the geometries of the monitor's display area).

It is also understood that the conditioning component may be implemented to provide for conditioning through a combination of such selective processing and controlling.

The conditioning component effectuates such processes or controls via selected signal processing. The signal processing may be conducted in the analog domain, the digital domain or in some combination thereof. The signal processing typically includes one or more of the following: amplification, attenuation, filtering, mixing, adding, multiplying, interpolating, extrapolating, phase shifting and frequency shifting. The signal processing may be applied to all or selected

portions of at least one of the acquired image, the output image and the intermediate image.

Moreover, the signal processing typically varies across the acquired, output and intermediate images. As an example, the signal processing may be directed to increasing the brightness in some parts of an image while decreasing it in others. These increases and decreases may or may not have symmetry, or may have portions of symmetry or asymmetry, across an image.

The conditioning component preferably is responsive to the target image. That is, the conditioning component preferably is implemented to condition the acquired, output and/or intermediate images as to the parameters, qualities and/or characteristics associated with the target image. To do so, the conditioning component typically provides for conditioning based on one or more calibrations (see, e.g., the learning modes of the alternative embodiments described above with reference to Figs. 17 and 18). Such calibration can be variously implemented, particularly in the context of a medical procedures. Example calibrations include: calibration previous to a medical procedure; manual calibration performed one or more times during a medical procedure; automatic calibration performed at regular intervals during the medical procedure; automatic calibration performed at intervals during the medical procedure based on selected triggering events; and dynamic calibration performed during the medical procedure.

Calibration may also be responsive to empirical information relevant to the medical procedure. As an example, calibration may be responsive to the detection threshold associated with differential picture brightness. Accordingly, the calibration may be directed to identify variations in performance relative to the detection threshold (e.g., whether the variations are detectable), and to provide for conditioning based thereon.

The conditioning component 2218 may be variously disposed. The disposition depends on whether the component 2218 is implemented as part of a medical instrument or as part of a medical system. As an example, the conditioning component 2218 may be integral, in whole or

part, with either the image acquisition component 2214 or the image output component 2216. As another example, the conditioning component 2218 may be integral, in whole or part, with both the image acquisition component 2214 and the image output component 2216. In this latter example, the image acquisition component 2214, the image output component 2216, and the conditioning component 2218 may be integrated in a medical imaging instrument, such that the image output component 2216 is an interface technology which connects the medical imaging instrument with, separate from the medical imaging instrument, at least one output device, photonic device and interface technology.

The output component 2216 preferably is coupled with the image acquisition component 2214. Depending on the implementation of the conditioning component 2218, these components 2216, 2214 may be coupled directly (via coupling 2220), indirectly (via the conditioning component 2228), or both. If coupled directly, the output component 2216 preferably receives acquired images via the coupling 2200. If coupled indirectly, the output component 2216 may receive acquired images from the conditioning component 2218 (via coupling 2224), which acquired images may be wholly or partially conditioned, or not conditioned at all. If the acquired images are partially conditioned or not conditioned, the output component 2216 preferably also receives appropriate conditioning signals from the conditioning component 2218, such conditioning signals providing for conditioning of the acquired, output or intermediate images within the output component 2216. Moreover, such conditioning signals may be provided via output 2226 to other output devices/photonic devices/interface technologies, so as to control conditioning of acquired, output and/or intermediate image received or generated therein.

The invention also contemplates a method for use in imaging a target site in a medical procedure. In such method, the target site is subject to deficient illumination. Moreover, the methods responds to the target site having associated therewith a target image, that target image

being selected respecting the deficient illumination. The method includes the steps of generating an acquired image of the target site, generating an output image of the target site, and conditioning at least one of the acquired image, the output image and an intermediate image. The method preferably provides for enhanced correlation of the output image to the target image. In particular, the method provides for conditioning to selectively reduce differential picture brightness across all or selected portions of an output image. The method contemplates operations in either/both the analog and digital domains.

The method contemplates conditioning provided by at least one of (i) selectively processing all or selected portions of at least one of an acquired image, an output image and an intermediate image, (ii) selectively controlling at least one of the generating of an acquired image and the generating of an output image, and (iii) a combination of such processing and controlling. In such processing/controlling, the method contemplates conditioning by providing selectively for at least one of amplification, attenuation, filtering, mixing, adding, multiplying, interpolation, extrapolation, phase shifting and frequency shifting to all or selected portions of at least one of an acquired image, an output image and an intermediate image.

As an example, the method contemplates conditioning by controlling the generating of an acquired image and, in the specific case where an acquisition area has a brightness sensitivity that is controllable as a function of the acquisition area position, by selectively controlling the brightness sensitivity respecting the acquisition area position. As another example, the method contemplates conditioning by controlling the generating of an output image and, specifically in the case where an output space has a brightness sensitivity that is controllable as a function of position in the output space, by selectively controlling the brightness sensitivity respecting the output area position.

Because an acquired image may be generated as an optical signal and/or as an

electrical signal, the method contemplates providing conditioning of either of both of these signals. Similarly, because an output image may be generated as an optical signal and/or as an electrical signal, the method contemplates providing conditioning of either of both of these signals.

The method preferably is responsive to the target image. That is, the method preferably is implemented to provide conditioning of the acquired, output and/or intermediate images as to the parameters, qualities and/or characteristics associated with the target image. To do so, the method preferably provides for conditioning based on one or more calibrations (see, e.g., the learning modes of the alternative embodiments described above with reference to Figs. 17 and 18). Such calibrating can be variously implemented, particularly in the context of a medical procedures. Example approaches for calibrating include: calibrating previous to a medical procedure; manually calibrating, in particular performed one or more times during a medical procedure; automatically calibrating, in particular performed at regular intervals during the medical procedure; automatically calibrating, in particular performed at intervals during the medical procedure based on selected triggering events; and dynamically calibrating performed during the medical procedure. Calibrating may also be responsive to empirical information relevant to the medical procedure (e.g., the detection threshold associated with differential picture brightness).

As previously described, the invention also contemplates a medical system wherein the target site is illuminated, at least in part, using frequencies other than visible light. These frequencies may be variously employed, including, as examples, toward enhancing acquisition, conditioning and/or output of an image (as described below) or toward recognition of the target site, portion(s) thereof and/or anomalies therein (such recognition may also be employed in the enhancing process). As examples, the illumination includes ultrasonic radiation and/or electro-magnetic radiation in the infrared and/or x-ray spectrums. Based on reflections, absorptions and/or transmissions of that or other such radiation, the image acquisition component preferably generates